
Backend.AI Client SDK for Python Documentation

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This is the documentation for the Python Client SDK which implements [the Backend.AI API](#).

QUICKSTART

Python 3.6 or higher is required.

You can download [its official installer from python.org](#), or use a 3rd-party package/version manager such as [homebrew](#), [miniconda](#), or [pyenv](#). It works on Linux, macOS, and Windows.

We recommend to create a virtual environment for isolated, unobtrusive installation of the client SDK library and tools.

```
$ python3 -m venv venv-backend-ai
$ source venv-backend-ai/bin/activate
(venv-backend-ai) $
```

Then install the client library from PyPI.

```
(venv-backend-ai) $ pip install -U pip setuptools
(venv-backend-ai) $ pip install backend.ai-client
```

Set your API keypair as environment variables:

```
(venv-backend-ai) $ export BACKEND_ACCESS_KEY=AKIA...
(venv-backend-ai) $ export BACKEND_SECRET_KEY=...
```

And then try the first commands:

```
(venv-backend-ai) $ backend.ai --help
...
(venv-backend-ai) $ backend.ai ps
...
```

Check out more details about [client configuration](#), the command-line examples, and [SDK code examples](#).

GETTING STARTED

2.1 Installation

2.1.1 Linux/macOS

We recommend using [pyenv](#) to manage your Python versions and virtual environments to avoid conflicts with other Python applications.

Create a new virtual environment (Python 3.6 or higher) and activate it on your shell. Then run the following commands:

```
pip install -U pip setuptools
pip install -U backend.ai-client-py
```

Create a shell script `my-backendai-env.sh` like:

```
export BACKEND_ACCESS_KEY=...
export BACKEND_SECRET_KEY=...
export BACKEND_ENDPOINT=https://my-precious-cluster
export BACKEND_ENDPOINT_TYPE=api
```

Run this shell script before using `backend.ai` command.

Note: The console-server users should set `BACKEND_ENDPOINT_TYPE` to `session`. For details, check out [the client configuration document](#).

2.1.2 Windows

We recommend using the [Anaconda Navigator](#) to manage your Python environments with a slick GUI app.

Create a new environment (Python 3.6 or higher) and launch a terminal (command prompt). Then run the following commands:

```
python -m pip install -U pip setuptools
python -m pip install -U backend.ai-client-py
```

Create a batch file `my-backendai-env.bat` like:

```
chcp 65001
set PYTHONIOENCODING=UTF-8
set BACKEND_ACCESS_KEY=...
set BACKEND_SECRET_KEY=...
set BACKEND_ENDPOINT=https://my-precious-cluster
set BACKEND_ENDPOINT_TYPE=api
```

Run this batch file before using `backend.ai` command.

Note that this batch file switches your command prompt to use the UTF-8 codepage for correct display of special characters in the console logs.

2.1.3 Verification

Run `backend.ai ps` command and check if it says “there is no compute sessions running” or something similar.

If you encounter error messages about “ACCESS_KEY”, then check if your batch/shell scripts have the correct environment variable names.

If you encounter network connection error messages, check if the endpoint server is configured correctly and accessible.

2.2 Client Configuration

The configuration for Backend.AI API includes the endpoint URL prefix, API keypairs (access and secret keys), and a few others.

There are two ways to set the configuration:

1. Setting environment variables before running your program that uses this SDK. This applies to the command-line interface as well.
2. Manually creating *APIConfig* instance and creating sessions with it.

The list of configurable environment variables are:

- `BACKEND_ENDPOINT`
- `BACKEND_ENDPOINT_TYPE`
- `BACKEND_ACCESS_KEY`
- `BACKEND_SECRET_KEY`
- `BACKEND_VFOLDER_MOUNTS`

Please refer the parameter descriptions of *APIConfig*'s constructor for what each environment variable means and what value format should be used.

2.3 CLI Quickstart

2.3.1 Display Help Text

You can print the help text for a command by suffixing `-h` or `--help`.

```
$ backend.ai <cmd> -h
$ backend.ai <cmd> --help
```

2.3.2 Login

Login to gain access to the Backend.AI server. `BACKEND_ENDPOINT_TYPE` should be set to `session`, and you need to specify `BACKEND_ENDPOINT` correctly.

```
$ export BACKEND_ENDPOINT_TYPE=session
$ export BACKEND_ENDPOINT=<backend-session-endpoint>
$ backend.ai login
User ID: myaccount@example.com
Password:
✓ Login succeeded.
```

2.3.3 Creating and Using Compute Session

Backend.AI's compute session provides a dedicated sandbox environment to run machine learning code and do any other tasks which are available for Linux.

Query running compute sessions

```
$ backend.ai ps
There are no matching sessions.
```

Execute inline code

Specify inline code with `-c` option. This will create a new compute session and execute the code. You can destroy the compute session by `rm` command.

```
$ backend.ai run -c "print('hello')" \
    lablup/python-tensorflow:2.3-py36-cuda10.1
Session name prefix: pysdk-6dd0b298df
✓ [0] Session pysdk-6dd0b298df is ready (domain=default, group=default).
hello
✓ [0] Execution finished. (exit code = 0)
$ backend.ai ps
Session Name      Task/Kernel ID      Image
↪              Type          Status      Status Info      Last_
↪updated              Result
-----
↪-----
↪-----
pysdk-6dd0b298df  106779ac-a997-4456-8612-fc6eca8bd2d5  index.docker.io/lablup/
↪python-tensorflow:2.3-py36-cuda10.1  INTERACTIVE  RUNNING          2020-
↪10-27T05:05:15.105235+00:00  UNDEFINED
$ backend.ai rm pysdk-6dd0b298df
✓ Done.
$ backend.ai ps
There are no matching sessions.
```

Note: If the code execution failed, you may not belong to the default domain and group. You can check your domain and group by:

```
$ backend.ai admin domain
$ backend.ai admin groups
```

To specify non-default domain and group,

```
$ backend.ai run -d <domain-name> -g <group-name> \
    -c "print('hello')" lablup/python-tensorflow:2.3-py36-cuda10.1
```

Execute file

Specify a local code file (mycode.py below) and a command to execute on the compute session with `--exec` parameter (`--exec "python mycode.py"`). The local code will be uploaded to the compute session and be executed by the command given in `--exec`.

With `--rm` option, the compute session will be automatically terminated after executing the code.

```
$ backend.ai run --rm --exec "python mycode.py" \
    lablup/python-tensorflow:2.3-py36-cuda10.1 mycode.py
Session name prefix: pysdk-be065c2666
✓ [0] Session pysdk-be065c2666 is ready (domain=default, group=default).
Uploading files: 100%| 25.0/25.0 [00:00<00:00, 157bytes/s, file=mycode.py]
✓ [0] Uploading done.
✓ [0] Clean finished. (exit code = 0)
python-kernel: python-kernel: skipping the build phase due to missing "setup.py"
↪file
✓ [0] Build finished. (exit code = 0)
this is my code
✓ [0] Execution finished. (exit code = 0)
✓ [0] Cleaned up the session.
```

Run code with specific resources

Backend.AI offers virtualized compute resources per compute session, such as CPU core(s), main memory, GPU(s), and etc. To specify resources for a compute session, you can rely on `-r <resource>=<value>` option.

Backend.AI offers a fractional GPU sharing (TM), so you can allocate a fraction of single physical GPU to your compute session.

Note: Fractional GPU sharing is only available on Backend.AI Enterprise edition. For open source version, you can only allocate GPUs as a physical unit.

Let's execute a code to check CPU and memory status inside a compute session. Save the python code below on your local machine with the file name `main.py`

```
def cpu_number(a,b):
    return list(range(a, b+1))

with open("/sys/fs/cgroup/memory/memory.limit_in_bytes") as fd:
    contents = fd.read()
    print("Memory: {} GB\n * Real value: {}".format(int(contents) /1024/1024/1024,
↪ contents))
```

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```
with open("/sys/fs/cgroup/cpuset/cpuset.cpus") as fd:
    contents = fd.read()
    cpu_numbers = cpu_number(*[ int(x.strip()) for x in contents.split('-' ) ]) \
    if '-' in contents else [int(contents.strip())]
    print("Number of CPU(s): {} \n * CPU core number(s) {}".format(len(cpu_
↪numbers), cpu_numbers))
```

And run the code to check the resources. Here, we specified 3 cpus, 2g memory, and 0.5 fraction of GPU unit (cuda.shares option). For open source version, you must specify GPU resources with cuda.device option, like cuda.device=2 to allocate 2 physical GPUs to the compute session.

Note: If the file name is main.py, you do not need to supply --exec parameter since main.py is the default file name.

```
$ backend.ai run -r cpu=3 -r mem=2g -r cuda.shares=0.5 \
    lablup/python-tensorflow:2.3-py36-cuda10.1 main.py
Session name prefix: pysdk-59405ab5a0
✓ [0] Session pysdk-b53bbf9abb is ready (domain=default, group=default).
Uploading files: 100%| 552/552 [00:00<00:00, 6.90kbytes/s, file=main.py]
✓ [0] Uploading done.
✓ [0] Clean finished. (exit code = 0)
python-kernel: python-kernel: skipping the build phase due to missing "setup.py"
↪file
✓ [0] Build finished. (exit code = 0)
Memory: 1.9375 GB
* Real value: 2080374784

Number of CPU(s): 3
* CPU core number(s) [0, 1, 2]
✓ [0] Execution finished. (exit code = 0)
```

You see the result matches the resources specified by -r option.

Now, check the allocated amount of GPU. This time, by using -t <session-name> option, we can recycle the already running compute session, not creating new one. Also, note that we specified --exec option to execute nvidia-smi command instead of executing main.py.

```
$ backend.ai ps -f name,occupied_slots,status,image
Session Name      Occupied Resource      Status
↪ Image
-----
↪ -----
pysdk-b53bbf9abb {"cpu": "3", "mem": "2147483648", "cuda.shares": "0.5"} RUNNING
↪ index.docker.io/lablup/python-tensorflow:2.3-py36-cuda10.1 (continues on next page)
```


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```

$ backend.ai run -t pysdk-b53bbf9abb --exec "nvidia-smi" \
  lablup/python-tensorflow:2.3-py36-cuda10.1 main.py
Session name prefix: pysdk-b53bbf9abb
✓ [0] Reusing session pysdk-b53bbf9abb...
Uploading files: 100%|| 552/552 [00:00<00:00, 6.95kbytes/s, file=main.py]
✓ [0] Uploading done.
✓ [0] Clean finished. (exit code = 0)
python-kernel: python-kernel: skipping the build phase due to missing "setup.py"
↪file
✓ [0] Build finished. (exit code = 0)
Tue Oct 27 05:40:22 2020
+-----+
| NVIDIA-SMI 450.51.06    Driver Version: 450.51.06    CUDA Version: 11.0    |
|-----+-----+-----+-----+-----+-----+
| GPU   Name           Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf    Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |
|                                           | MIG M.         |
|====+====+====+====+====+====+====+====+====+====+====+====+====+====+====+====+
|  0   CUDA GPU              Off    | 00000000:01:00:0 Off |                 N/A |
| 0%   47C   P8     11W / 151W | 16MiB / 2029MiB |      0%   Default |
|                                           |                 N/A |
+-----+-----+-----+-----+-----+-----+
+-----+
| Processes:
| GPU   GI   CI          PID   Type   Process name                      GPU Memory
|      ID   ID
|                                           Usage
+-----+
| No running processes found
+-----+
✓ [0] Execution finished. (exit code = 0)

```

Note that only half of the GPU memory is allocated (~2 GiB), which shows fractional GPU sharing is working.

Note: The amount of 1 fraction GPU unit (fGPU) may differ depending on the server setting. The exact GPU unit configuration should be check by the admins, if needed.

If you're done, destroy the compute session.

```

$ backend.ai rm pysdk-b53bbf9abb
✓ Done.

```

2.3.4 Data Storage Folder

By default, data (files and folders) created and updated inside a compute session are volatile, meaning they are lost when the session is terminated. To keep data after session termination, you can save data to a data storage folder, which we call virtual folder.

Create a storage folder (virtual folder)

Backend.AI supports multiple file systems simultaneously, so to create a virtual folder, you need to query and choose what host to use beforehand.

To query and create a virtual folder, follow the steps below.

```
$ backend.ai vfolder list
There is no virtual folders created yet.
$ backend.ai vfolder list-hosts # list possible virtual folder hosts
Default vfolder host: local
Usable hosts: local # in this case, "local" is our host
$ backend.ai vfolder create myfolder local
Virtual folder "myfolder" is created.
$ backend.ai vfolder list
```

Name	ID	Owner	Permission	Owership Type
↪ Usage Mode	User		Group	
-----	-----	-----	-----	-----
↪	-----	-----	-----	-----
myfolder	154523348d844cd1bddbfaa43024a823	True	rw	user
↪ general	dfa9da54-4b28-432f-be29-c0d680c7a412			

Using virtual folder

It's time to create a compute session with virtual folder mounted. In the example below, -m option is used to mount just created myfolder. This folder is mounted under /home/work/ inside the compute session. Let's check this is true by executing ls command on /home/work inside the compute session.

```
$ backend.ai run --rm --exec "ls /home/work" \
  lablup/python-tensorflow:2.3-py36-cuda10.1 main.py
Session name prefix: pysdk-ffa1b5d3be
✓ [0] Session pysdk-ffa1b5d3be is ready (domain=default, group=default).
Uploading files: 100%| 552/552 [00:00<00:00, 6.80kbytes/s, file=main.py]
✓ [0] Uploading done.
✓ [0] Clean finished. (exit code = 0)
python-kernel: python-kernel: skipping the build phase due to missing "setup.py"
↪file
✓ [0] Build finished. (exit code = 0)
```

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```

bootstrap.sh
id_container
main.py
✓ [0] Execution finished. (exit code = 0)
✓ [0] Cleaned up the session.
$
$ backend.ai run --rm -m myfolder --exec "ls /home/work" \
    lablup/python-tensorflow:2.3-py36-cuda10.1 main.py
  Session name prefix: pysdk-7adc7a4cf5
✓ [0] Session pysdk-7adc7a4cf5 is ready (domain=default, group=default).
Uploading files: 100%| 552/552 [00:00<00:00, 6.04kbytes/s, file=main.py]
✓ [0] Uploading done.
✓ [0] Clean finished. (exit code = 0)
python-kernel: python-kernel: skipping the build phase due to missing "setup.py"
↪file
✓ [0] Build finished. (exit code = 0)
bootstrap.sh
id_container
main.py
myfolder
✓ [0] Execution finished. (exit code = 0)
✓ [0] Cleaned up the session.

```

Note that `/home/work/myfolder` only appears when `-m` option is used. If you create a file inside virtual folder (`myfolder` in this case), it will be preserved after compute session is terminated (`--rm`). You can check this by using `vfolder ls` command, which displays the file/directory inside a specific virtual folder.

```

$ backend.ai vfolder ls myfolder
✓ Retrived.
file name      size      modified    mode
-----
$ backend.ai run --rm -m myfolder --exec "touch /home/work/myfolder/file-preserved
↪" \
    lablup/python-tensorflow:2.3-py36-cuda10.1 main.py
  Session name prefix: pysdk-95c788a7b2
✓ [0] Session pysdk-95c788a7b2 is ready (domain=default, group=default).
Uploading files: 100%| 552/552 [00:00<00:00, 5.73kbytes/s, file=main.py]
✓ [0] Uploading done.
✓ [0] Clean finished. (exit code = 0)
python-kernel: python-kernel: skipping the build phase due to missing "setup.py"
↪file
✓ [0] Build finished. (exit code = 0)
✓ [0] Execution finished. (exit code = 0)
✓ [0] Cleaned up the session.
$ backend.ai vfolder ls myfolder

```

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```
backend.ai vfolder ls myfolder
✓ Retrived.
file name          size  modified          mode
-----
file-preserved     0    Oct 27 2020 15:28:40  -rw-r--r--
```

Warning: Keep in mind that If you want to preserve any data generated from the compute session, you must mount at least one virtual folder, and save the data under it.

2.3.5 Using Interactive Apps

Backend.AI CLI provides web-based interactive apps, but for now, this feature is only available in API (KeyPair) connection mode.

API (KeyPair) Connection Mode

In API connection mode, you don't need to login with your email and password, but need to provide additional environment variables. The endpoint for API connection mode and access-/secret-key should be got from your Backend.AI admins.

```
$ export BACKEND_ENDPOINT_TYPE=api
$ # This endpoint may differ from the one used for session mode.
$ export BACKEND_ENDPOINT=<backend-api-endpoint>
$ export BACKEND_ACCESS_KEY=<access-key>
$ export BACKEND_SECRET_KEY=<secret-key>
```

Start a compute session

You can create a compute session without executing any code. Note that there is no --rm option in the example below, and we specified session name with -t option.

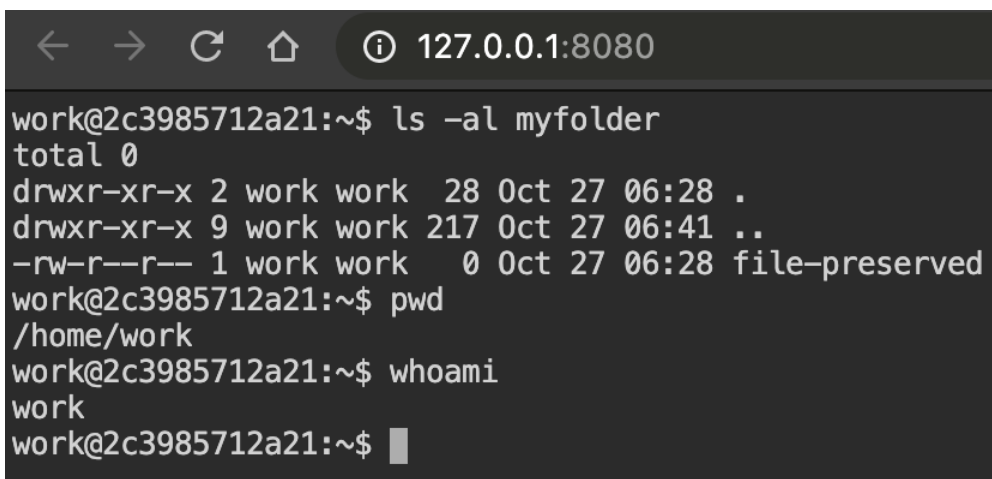
```
$ backend.ai start -t app-test -m myfolder \
  -r cpu=4 -r mem=8g -r cuda.shares=1 \
  lablup/python-tensorflow:2.3-py36-cuda10.1
Session ID 70e265d4-52b5-4084-86d0-b6c2625c5e4a is created and ready.
This session provides the following app services: jupyter, jupyterlab, vscode, ↵
↵ tensorboard, sshd, ttyd
```

Launch Terminal

From the last message of the above code block, you can see that the session reports app services available, such as jupyter, ttyd, etc. These are the list of interactive apps, mostly provide web-based easy-to-use UI. Here, let's launch a web-terminal (ttyd) using app command.

```
$ backend.ai app app-test ttyd
A local proxy to the application "ttyd" provided by the session "app-test" is
↪available at:
  http://127.0.0.1:8080
```

Open your web browser, and type <http://127.0.0.1:8080> in the URL bar. You are now connected to the compute session through web-based terminal. Every command you typically use from a terminal will work.

A screenshot of a web browser terminal window. The address bar shows '127.0.0.1:8080'. The terminal content shows a shell session with the following commands and output:

```
work@2c3985712a21:~$ ls -al myfolder
total 0
drwxr-xr-x 2 work work 28 Oct 27 06:28 .
drwxr-xr-x 9 work work 217 Oct 27 06:41 ..
-rw-r--r-- 1 work work 0 Oct 27 06:28 file-preserved
work@2c3985712a21:~$ pwd
/home/work
work@2c3985712a21:~$ whoami
work
work@2c3985712a21:~$
```

Web terminal deploys tmux by default, so you can use powerful features provided by tmux, if you want.

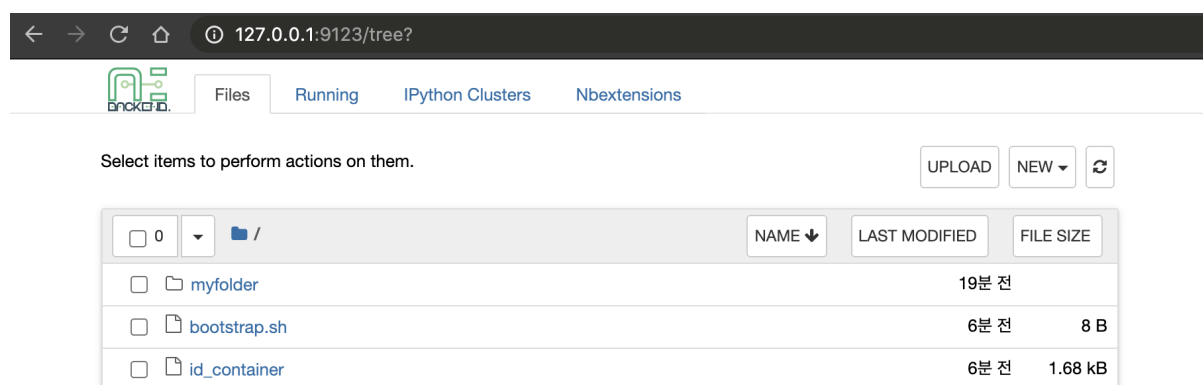
If you're done, press Ctrl-C to cancel the ttyd web service.

Launch Jupyter Notebook

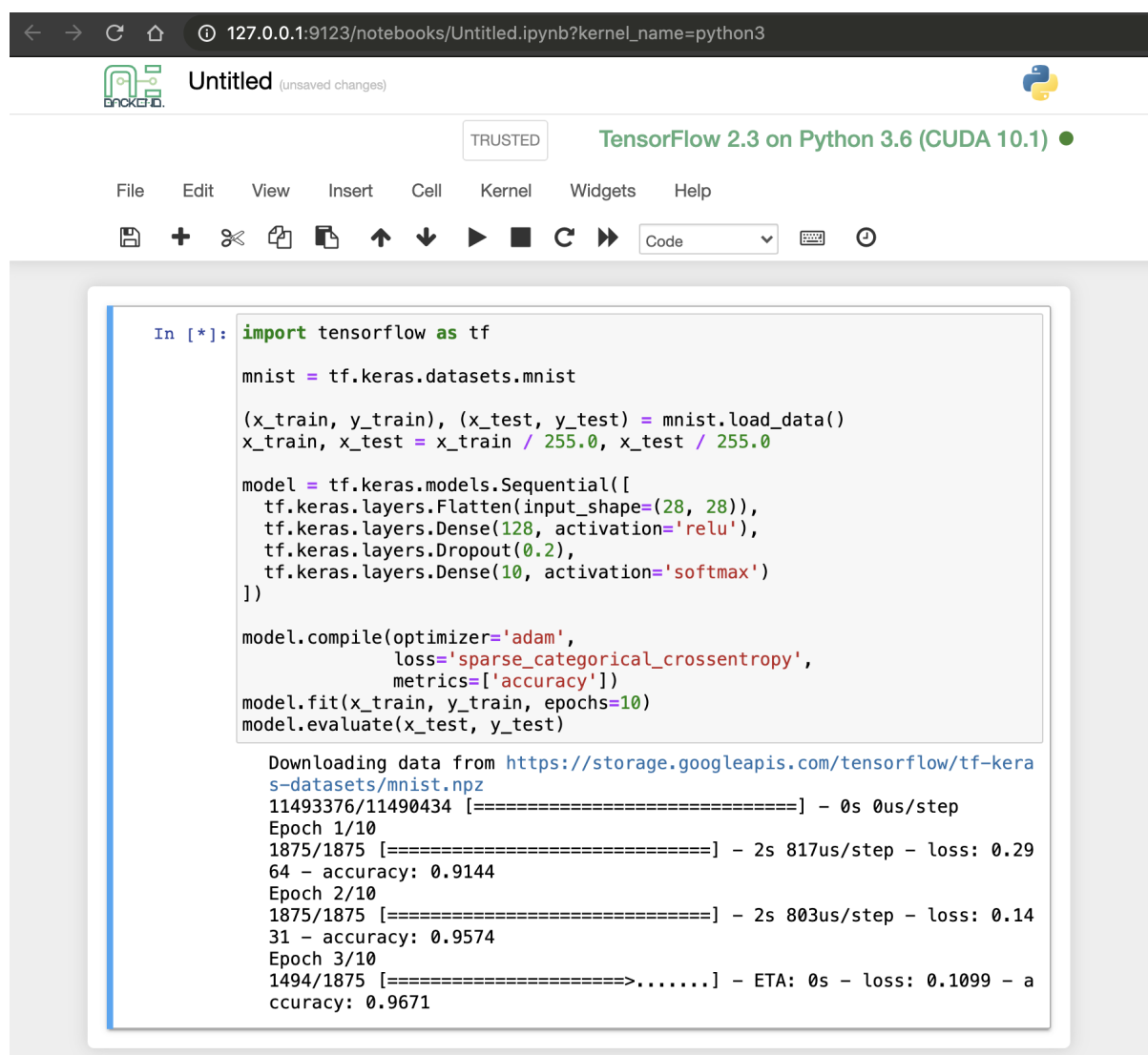
With -b (bind) option, you can launch the app from any local port.

```
$ backend.ai app -b 9123 app-test jupyter
A local proxy to the application "jupyter" provided by the session "app-test" is
↪available at:
  http://127.0.0.1:9123
```

This time, open <http://127.0.0.1:9123> from your browser. You can now use Jupyter Notebook app. No need to install python.



A ML code can also be executed directly without installing 3rd party packages.



If you're done, press Ctrl-C to cancel the Jupyter Notebook service.

SSH into the Compute Session

Backend.AI supports OpenSSH-based public key connection (RSA2048). A SSH private key is placed at `/home/work/id_container` for user's convenience, so you can establish real SSH connection into the compute session.

Note: To access with a client such as PuTTY on Windows, a private key (`id_container`) must be converted into a ppk file through a program such as PuTTYgen. You can refer to the following link for the conversion method: <https://wiki.filezilla-project.org/Howto>.

```
$ # download /home/work/id_container
$ backend.ai download app-test id_container
$ mv id_container ~/.ssh/id_container
$ backend.ai app app-test sshd -b 9922
A local proxy to the application "sshd" provided by the session "app-test" is
↪available at:
  http://127.0.0.1:9922
```

In another terminal on the same PC:

```
$ ssh -o StrictHostKeyChecking=no \
> -o UserKnownHostsFile=/dev/null \
> -i ~/.ssh/id_container \
> work@localhost -p 9922
Warning: Permanently added '[localhost]:9922' (RSA) to the list of known hosts.
work@dab597c32a10:~$ ls -al myfolder
total 0
drwxr-xr-x 2 work work 28 Oct 27 06:28 .
drwxr-xr-x 9 work work 217 Oct 27 06:57 ..
-rw-r--r-- 1 work work  0 Oct 27 06:28 file-preserved
work@dab597c32a10:~$ pwd
/home/work
work@dab597c32a10:~$ whoami
work
work@dab597c32a10:~$
```

You can easily open sFTP connection with the same way.

COMMAND-LINE INTERFACE

3.1 Configuration

Note: Please consult the detailed usage in the help of each command (use `-h` or `--help` argument to display the manual).

Check out [the client configuration](#) for configurations via environment variables.

3.1.1 Session Mode

When the endpoint type is "session", you must explicitly login and logout into/from the console server.

```
$ backend.ai login
Username: myaccount@example.com
Password:
✓ Login succeeded.

$ backend.ai ... # any commands

$ backend.ai logout
✓ Logout done.
```

3.1.2 API Mode

After setting up the environment variables, just run any command:

```
$ backend.ai ...
```

3.1.3 Checking out the current configuration

Run the following command to list your current active configurations.

```
$ backend.ai config
```

3.2 Compute Sessions

Note: Please consult the detailed usage in the help of each command (use `-h` or `--help` argument to display the manual).

3.2.1 Listing sessions

List the session owned by you with various status filters. The most recently status-changed sessions are listed first. To prevent overloading the server, the result is limited to the first 10 sessions and it provides a separate `--all` option to paginate further sessions.

```
backend.ai ps
```

The `ps` command is an alias of the following `admin sessions` command. If you have the administrator privilege, you can list sessions owned by other users by adding `--access-key` option here.

```
backend.ai admin sessions
```

Both commands offer options to set the status filter as follows. For other options, please consult the output of `--help`.

Option	Included Session Status
(no option)	PENDING, PREPARING, RUNNING, RESTARTING, TERMINATING, RESIZING, SUSPENDED, and ERROR.
<code>--running</code>	PREPARING, PULLING, and RUNNING.
<code>--dead</code>	CANCELLED and TERMINATED.

Both commands offer options to specify which fields of sessions should be printed as follows.

Option	Included Session Fields
(no option)	Session ID, Owner, Image, Type, Status, Status Info, Last updated, and Result.
--id-only	Session ID.
--detail	Session ID, Owner, Image, Type, Status, Status Info, Last updated, Result, Tag, Created At, Occupied Resource, Used Memory (MiB), Max Used Memory (MiB), and CPU Using (%).
-f, --format	Specified fields by user.

Note: Fields for -f/--format option can be displayed by specifying comma-separated parameters.

Available parameters for this option are: id, status, status_info, created_at, last_updated, result, image, type, task_id, tag, occupied_slots, used_memory, max_used_memory, cpu_using.

For example:

```
backend.ai admin session --format id,status,cpu_using
```

3.2.2 Running simple sessions

The following command spawns a Python session and executes the code passed as -c argument immediately. --rm option states that the client automatically terminates the session after execution finishes.

```
backend.ai run --rm -c 'print("hello world")' python:3.6-ubuntu18.04
```

Note: By default, you need to specify language with full version tag like python:3.6-ubuntu18.04. Depending on the Backend.AI admin's language alias settings, this can be shortened just as python. If you want to know defined language aliases, contact the admin of Backend.AI server.

The following command spawns a Python session and executes the code passed as ./myscript.py file, using the shell command specified in the --exec option.

```
backend.ai run --rm --exec 'python myscript.py arg1 arg2' \  
python:3.6-ubuntu18.04 ./myscript.py
```

Please note that your run command may hang up for a very long time due to queueing when the cluster resource is not sufficiently available.

To avoid indefinite waiting, you may add `--enqueue-only` to return immediately after posting the session creation request.

Note: When using `--enqueue-only`, the codes are *NOT* executed and relevant options are ignored. This makes the run command to the same of the start command.

Or, you may use `--max-wait` option to limit the maximum waiting time. If the session starts within the given `--max-wait` seconds, it works normally, but if not, it returns without code execution like when used `--enqueue-only`.

To watch what is happening behind the scene until the session starts, try `backend.ai events <sessionID>` to receive the lifecycle events such as its scheduling and preparation steps.

3.2.3 Running sessions with accelerators

Use one or more `-r` options to specify resource requirements when using `backend.ai run` and `backend.ai start` commands.

For instance, the following command spawns a Python TensorFlow session using a half of virtual GPU device, 4 CPU cores, and 8 GiB of the main memory to execute `./mygpucode.py` file inside it.

```
backend.ai run --rm \  
    -r cpu=4 -r mem=8g -r cuda.shares=2 \  
    python-tensorflow:1.12-py36 ./mygpucode.py
```

3.2.4 Terminating or cancelling sessions

Without `--rm` option, your session remains alive for a configured amount of idle timeout (default is 30 minutes). You can see such sessions using the `backend.ai ps` command. Use the following command to manually terminate them via their session IDs. You may specify multiple session IDs to terminate them at once.

```
backend.ai rm <sessionID> [<sessionID>...]
```

If you terminate PENDING sessions which are not scheduled yet, they are cancelled.

3.3 Container Applications

Note: Please consult the detailed usage in the help of each command (use `-h` or `--help` argument to display the manual).

3.3.1 Starting a session and connecting to its Jupyter Notebook

The following command first spawns a Python session named “mysession” without running any code immediately, and then executes a local proxy which connects to the “jupyter” service running inside the session via the local TCP port 9900. The `start` command shows application services provided by the created compute session so that you can choose one in the subsequent `app` command. In the `start` command, you can specify detailed resource options using `-r` and storage mounts using `-m` parameter.

```
backend.ai start -t mysession python
backend.ai app -b 9900 mysession jupyter
```

Once executed, the `app` command waits for the user to open the displayed address using appropriate application. For the jupyter service, use your favorite web browser just like the way you use Jupyter Notebooks. To stop the `app` command, press `Ctrl+C` or send the `SIGINT` signal.

3.3.2 Accessing sessions via a web terminal

All Backend.AI sessions expose an intrinsic application named “ttyd”. It is a web application that embeds xterm.js-based full-screen terminal that runs on web browsers.

```
backend.ai start -t mysession ...
backend.ai app -b 9900 mysession ttyd
```

Then open `http://localhost:9900` to access the shell in a fully functional web terminal using browsers. The default shell is `/bin/bash` for Ubuntu/CentOS-based images and `/bin/ash` for Alpine-based images with a fallback to `/bin/sh`.

Note: This shell access does *NOT* grant your root access. All compute session processes are executed as the user privilege.

3.3.3 Accessing sessions via native SSH/SFTP

Backend.AI offers direct access to compute sessions (containers) via SSH and SFTP, by auto-generating host identity and user keypairs for all sessions. All Backend.AI sessions expose an intrinsic application named "sshd" like "ttyd".

To connect your sessions with SSH, first prepare your session and download an auto-generated SSH keypair named `id_container`. Then start the service port proxy ("app" command) to open a local TCP port that proxies the SSH/SFTP traffic to the compute sessions:

```
$ backend.ai start -t mysess ...
$ backend.ai download mysess id_container
$ mv id_container ~/.ssh
$ backend.ai app mysess sshd -b 9922
```

In another terminal on the same PC, run your ssh client like:

```
$ ssh -o StrictHostKeyChecking=no \
> -o UserKnownHostsFile=/dev/null \
> -i ~/.ssh/id_container \
> work@localhost -p 9922
Warning: Permanently added '[127.0.0.1]:9922' (RSA) to the list of known hosts.
f310e8dbce83:~$
```

This SSH port is also compatible with SFTP to browse the container's filesystem and to upload/download large-sized files.

You could add the following to your `~/.ssh/config` to avoid type extra options every time.

```
Host localhost
  User work
  IdentityFile ~/.ssh/id_container
  StrictHostKeyChecking no
  UserKnownHostsFile /dev/null
```

```
$ ssh localhost -p 9922
```

Warning: Since the SSH keypair is auto-generated every time when you launch a new compute session, you need to download and keep it separately for each session.

To use your own SSH private key across all your sessions without downloading the auto-generated one every time, create a vfolder named `.ssh` and put the `authorized_keys` file that includes the public key. The keypair and `.ssh` directory permissions will be automatically updated by Backend.AI when the session launches.

```
$ ssh-keygen -t rsa -b 2048 -f id_container
$ cat id_container.pub > authorized_keys
$ backend.ai vfolder create .ssh
$ backend.ai vfolder upload .ssh authorized_keys
```

3.4 Storage Management

Note: Please consult the detailed usage in the help of each command (use `-h` or `--help` argument to display the manual).

Backend.AI abstracts shared network storages into per-user slices called “**virtual folders**” (aka “**vfolders**”), which can be shared between users and user group members.

3.4.1 Creating vfolders and managing them

The command-line interface provides a set of subcommands under `backend.ai vfolder` to manage vfolders and files inside them.

To list accessible vfolders including your own ones and those shared by other users:

```
$ backend.ai vfolder list
```

To create a virtual folder named “mydata1”:

```
$ backend.ai vfolder create mydata1 mynas
```

The second argument `mynas` corresponds to the name of a storage host. To list up storage hosts that you are allowed to use:

```
$ backend.ai vfolder list-hosts
```

To delete the vfolder completely:

```
$ backend.ai vfolder delete mydata1
```

3.4.2 File transfers and management

To upload a file from the current working directory into the vfolder:

```
$ backend.ai vfolder upload mydata1 ./bigdata.csv
```

To download a file from the vfolder into the current working directory:

```
$ backend.ai vfolder download mydata1 ./bigresult.txt
```

To list files in the vfolder's specific path:

```
$ backend.ai vfolder ls mydata1 .
```

To delete files in the vfolder:

```
$ backend.ai vfolder rm mydata1 ./bigdata.csv
```

Warning: All file uploads and downloads overwrite existing files and all file operations are irreversible.

3.4.3 Running sessions with storages

The following command spawns a Python session where the virtual folder "mydata1" is mounted. The execution options are omitted in this example. Then, it downloads ./bigresult.txt file (generated by your code) from the "mydata1" virtual folder.

```
$ backend.ai vfolder upload mydata1 ./bigdata.csv  
$ backend.ai run --rm -m mydata1 python:3.6-ubuntu18.04 ...  
$ backend.ai vfolder download mydata1 ./bigresult.txt
```

In your code, you may access the virtual folder via /home/work/mydata1 (where the default current working directory is /home/work) just like a normal directory.

By reusing the same vfolder in subsequent sessions, you do not have to download the result and upload it as the input for next sessions, just keeping them in the storage.

3.4.4 Creating default files for kernels

Backend.AI has a feature called ‘dotfile’, created to all the kernels user spawns. As you can guess, dotfile’s path should start with `..`. The following command creates dotfile named `.aws/config` with permission `755`. This file will be created under `/home/work` every time user spawns Backend.AI kernel.

```
$ backend.ai dotfile create .aws/config < ~/.aws/config
```

3.5 Advanced Code Execution

Note: Please consult the detailed usage in the help of each command (use `-h` or `--help` argument to display the manual).

3.5.1 Running concurrent experiment sessions

In addition to single-shot code execution as described in *Running simple sessions*, the `run` command offers concurrent execution of multiple sessions with different parameters interpolated in the execution command specified in `--exec` option and environment variables specified as `-e` / `--env` options.

To define variables interpolated in the `--exec` option, use `--exec-range`. To define variables interpolated in the `--env` options, use `--env-range`.

Here is an example with environment variable ranges that expands into 4 concurrent sessions.

```
backend.ai run -c 'import os; print("Hello world, {}".format(os.environ["CASENO"]))' \
→ ' \
  -r cpu=1 -r mem=256m \
  -e 'CASENO=$X' \
  --env-range=X=case:1,2,3,4 \
  lablup/python:3.6-ubuntu18.04
```

Both range options accept a special form of argument: “range expressions”. The front part of range option value consists of the variable name used for interpolation and an equivalence sign (=). The rest of range expressions have the following three types:

Expression	Interpretation
case:CASE1, CASE2, ..., CASEN	A list of discrete values. The values may be either string or numbers.
linspace:START, STOP,POINTS	An inclusive numerical range with discrete points, in the same way of <code>numpy.linspace()</code> . For example, <code>linspace:1,2,3</code> generates a list of three values: 1, 1.5, and 2.
range:START, STOP,STEP	A numerical range with the same semantics of Python's <code>range()</code> . For example, <code>range:1,6,2</code> generates a list of values: 1, 3, and 5.

If you specify multiple occurrences of range options in the run command, the client spawns sessions for *all possible combinations* of all values specified by each range.

Note: When your resource limit and cluster's resource capacity cannot run all spawned sessions at the same time, some of sessions may be queued and the command may take a long time to finish.

Warning: Until all cases finish, the client must keep its network connections to the server alive because this feature is implemented in the client-side. Server-side batch job scheduling is under development!

3.6 Session Templates

3.6.1 Creating and starting session template

Users may define commonly used set of session creation parameters as reusable templates.

A session template includes common session parameters such as resource slots, vfolder mounts, the kernel iamge to use, and etc. It also support an extra feature that automatically clones a Git repository upon startup as a bootstrap command.

The following sample shows how a session template looks like:

```
---  
api_version: v1  
kind: taskTemplate  
metadata:  
  name: template1234  
  tag: example-tag  
spec:  
  kernel:
```

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```
environ:
  MYCONFIG: XXX
git:
  branch: '19.09'
  commit: 10daee9e328876d75e6d0fa4998d4456711730db
  repository: https://github.com/lablup/backend.ai-agent
  destinationDir: /home/work/baiagent
  image: python:3.6-ubuntu18.04
resources:
  cpu: '2'
  mem: 4g
mounts:
  hostpath-test: /home/work/hostDesktop
  test-vfolder:
sessionType: interactive
```

The `backend.ai sesstpl` command set provides the basic CRUD operations of user-specific session templates.

The `create` command accepts the YAML content either piped from the standard input or read from a file using `-f` flag:

```
$ backend.ai sesstpl create < session-template.yaml
# -- or --
$ backend.ai sesstpl create -f session-template.yaml
```

Once the session template is uploaded, you may use it to start a new session:

```
$ backend.ai start-template <templateId>
```

with substituting `<templateId>` to your template ID.

Other CRUD command examples are as follows:

```
$ backend.ai sesstpl update <templateId> < session-template.yaml
$ backend.ai sesstpl list
$ backend.ai sesstpl get <templateId>
$ backend.ai sesstpl delete <templateId>
```

3.6.2 Full syntax for task template

```
---
api_version or apiVersion: str, required
kind: Enum['taskTemplate', 'task_template'], required
metadata: required
  name: str, required
  tag: str (optional)
spec:
  type or sessionType: Enum['interactive', 'batch'] (optional), default=interactive
  kernel:
    image: str, required
    environ: map[str, str] (optional)
    run: (optional)
      bootstrap: str (optional)
      stratup or startup_command or startupCommand: str (optional)
    git: (optional)
      repository: str, required
      commit: str (optional)
      branch: str (optional)
      credential: (optional)
        username: str
        password: str
      destination_dir or destinationDir: str (optional)
  mounts: map[str, str] (optional)
  resources: map[str, str] (optional)
```

4.1 Developer Guides

4.1.1 Client Session

This module is the first place to begin with your Python programs that use Backend.AI API functions.

The high-level API functions cannot be used alone – you must initiate a client session first because each session provides *proxy attributes* that represent API functions and run on the session itself.

To achieve this, during initialization session objects internally construct new types by combining the `BaseFunction` class with the attributes in each API function classes, and makes the new types bound to itself. Creating new types every time when creating a new session instance may look weird, but it is the most convenient way to provide *class-methods* in the API function classes to work with specific *session instances*.

When designing your application, please note that session objects are intended to live long following the process' lifecycle, instead of to be created and disposed whenever making API requests.

```
class ai.backend.client.session.BaseSession(*, config=None,  
                                             proxy_mode=False)
```

The base abstract class for sessions.

proxy_mode

If set True, it skips API version negotiation when opening the session.

Return type `bool`

abstractmethod `open()`

Initializes the session and perform version negotiation.

Return type `Union[None, Awaitable[None]]`

abstractmethod `close()`

Terminates the session and releases underlying resources.

Return type `Union[None, Awaitable[None]]`

closed

Checks if the session is closed.

Return type `bool`

config

The configuration used by this session object.

Return type `APIConfig`

class `ai.backend.client.session.Session(*, config=None, proxy_mode=False)`

A context manager for API client sessions that makes API requests synchronously. You may call simple request-response APIs like a plain Python function, but cannot use streaming APIs based on WebSocket and Server-Sent Events.

closed

Checks if the session is closed.

Return type `bool`

config

The configuration used by this session object.

Return type `APIConfig`

proxy_mode

If set True, it skips API version negotiation when opening the session.

Return type `bool`

open()

Initializes the session and perform version negotiation.

Return type `None`

close()

Terminates the session. It schedules the `close()` coroutime of the underlying `aiohttp` session and then enqueues a sentinel object to indicate termination. Then it waits until the worker thread to self-terminate by joining.

Return type `None`

worker_thread

The thread that internally executes the asynchronous implementations of the given API functions.

class `ai.backend.client.session.AsyncSession(*, config=None, proxy_mode=False)`

A context manager for API client sessions that makes API requests asynchronously. You may call all APIs as coroutines. WebSocket-based APIs and SSE-based APIs returns special response types.

closed

Checks if the session is closed.

Return type `bool`

config

The configuration used by this session object.

Return type `APIConfig`

proxy_mode

If set True, it skips API version negotiation when opening the session.

Return type `bool`

open()

Initializes the session and perform version negotiation.

Return type `Awaitable[None]`

close()

Terminates the session and releases underlying resources.

Return type `Awaitable[None]`

4.1.2 Examples

Synchronous-mode execution

Query mode

This is the minimal code to execute a code snippet with this client SDK.

```
import sys
from ai.backend.client import Session

with Session() as session:
    kern = session.ComputeSession.get_or_create('python:3.6-ubuntu18.04')
    code = 'print("hello world")'
    mode = 'query'
    run_id = None
    while True:
        result = kern.execute(run_id, code, mode=mode)
        run_id = result['runId'] # keeps track of this particular run loop
        for rec in result.get('console', []):
            if rec[0] == 'stdout':
                print(rec[1], end='', file=sys.stdout)
            elif rec[0] == 'stderr':
                print(rec[1], end='', file=sys.stderr)
```

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```

        else:
            handle_media(rec)
    sys.stdout.flush()
    if result['status'] == 'finished':
        break
    else:
        mode = 'continued'
        code = ''
kern.destroy()

```

You need to take care of `client_token` because it determines whether to reuse kernel sessions or not. Backend.AI cloud has a timeout so that it terminates long-idle kernel sessions, but within the timeout, any kernel creation requests with the same `client_token` let Backend.AI cloud to reuse the kernel.

Batch mode

You first need to upload the files after creating the session and construct a `opts` struct.

```

import sys
from ai.backend.client import Session

with Session() as session:
    kern = session.ComputeSession.get_or_create('python:3.6-ubuntu18.04')
    kern.upload(['mycode.py', 'setup.py'])
    code = ''
    mode = 'batch'
    run_id = None
    opts = {
        'build': '*', # calls "python setup.py install"
        'exec': 'python mycode.py arg1 arg2',
    }
    while True:
        result = kern.execute(run_id, code, mode=mode, opts=opts)
        opts.clear()
        run_id = result['runId']
        for rec in result.get('console', []):
            if rec[0] == 'stdout':
                print(rec[1], end='', file=sys.stdout)
            elif rec[0] == 'stderr':
                print(rec[1], end='', file=sys.stderr)
            else:
                handle_media(rec)
    sys.stdout.flush()
    if result['status'] == 'finished':

```

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```

        break
    else:
        mode = 'continued'
        code = ''
kern.destroy()

```

Handling user inputs

Inside the while-loop for `kern.execute()` above, change the if-block for `result['status']` as follows:

```

...
if result['status'] == 'finished':
    break
elif result['status'] == 'waiting-input':
    mode = 'input'
    if result['options'].get('is_password', False):
        code = getpass.getpass()
    else:
        code = input()
else:
    mode = 'continued'
    code = ''
...

```

A common gotcha is to miss setting `mode = 'input'`. Be careful!

Handling multi-media outputs

The `handle_media()` function used above examples would look like:

```

def handle_media(record):
    media_type = record[0] # MIME-Type string
    media_data = record[1] # content
    ...

```

The exact method to process `media_data` depends on the `media_type`. Currently the following behaviors are well-defined:

- For (binary-format) images, the content is a dataURI-encoded string.
- For SVG (scalable vector graphics) images, the content is an XML string.
- For `application/x-sorna-drawing`, the content is a JSON string that represents a set of vector drawing commands to be replayed the client-side (e.g., Javascript on

browsers)

Asynchronous-mode Execution

The async version has all sync-version interfaces as coroutines but comes with additional features such as `stream_execute()` which streams the execution results via websockets and `stream_ptty()` for interactive terminal streaming.

```
import asyncio
import json
import sys
import aiohttp
from ai.backend.client import AsyncSession

async def main():
    async with AsyncSession() as session:
        kern = await session.ComputeSession.get_or_create('python:3.6-ubuntu18.04',
                                                         client_token='mysession')

        code = 'print("hello world")'
        mode = 'query'
        async with kern.stream_execute(code, mode=mode) as stream:
            # no need for explicit run_id since WebSocket connection represents it!
            async for result in stream:
                if result.type != aiohttp.WSMsgType.TEXT:
                    continue
                result = json.loads(result.data)
                for rec in result.get('console', []):
                    if rec[0] == 'stdout':
                        print(rec[1], end='', file=sys.stdout)
                    elif rec[0] == 'stderr':
                        print(rec[1], end='', file=sys.stderr)
                    else:
                        handle_media(rec)
                sys.stdout.flush()
                if result['status'] == 'finished':
                    break
                elif result['status'] == 'waiting-input':
                    mode = 'input'
                    if result['options'].get('is_password', False):
                        code = getpass.getpass()
                    else:
                        code = input()
                    await stream.send_text(code)
                else:
                    mode = 'continued'
                    code = ''
```

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```
    await kern.destroy()

loop = asyncio.get_event_loop()
try:
    loop.run_until_complete(main())
finally:
    loop.stop()
```

New in version 1.5.

4.1.3 Testing

Unit Tests

Unit tests perform function-by-function tests to ensure their individual functionality. This test suite runs without depending on the server-side and thus it is executed in Travis CI for every push.

How to run

```
$ python -m pytest -m 'not integration' tests
```

Integration Tests

Integration tests combine multiple invocations of high-level interfaces to make underlying API requests to a running gateway server to test the full functionality of the client as well as the manager.

They are marked as “integration” using the `@pytest.mark.integration` decorator to each test case.

Warning: The integration tests actually make changes to the target gateway server and agents. If some tests fail, those changes may remain in an inconsistent state and requires a manual recovery such as resetting the database and populating fixtures again, though the test suite tries to clean up them properly.

So, DO NOT RUN it against your production server.

Prerequisite

Please refer the README of the manager and agent repositories to set up them. To avoid an indefinite waiting time for pulling Docker images:

- (manager) `python -m ai.backend.manager.cli etcd rescan-images`
- (agent) `docker pull`
 - `lablup/python:3.6-ubuntu18.04`
 - `lablup/lua:5.3-alpine3.8`

The manager must also have at least the following active `suerp-admin` account in the default domain and the default group.

- Example super-admin account:
 - User ID: `admin@lablup.com`
 - Password `wJalrXUt`
 - Access key: `AKIAIOSFODNN7EXAMPLE`
 - Secret key: `wJalrXUtnFEMI/K7MDENG/bPxrFiCYEXAMPLEKEY`

One or more `testing-XXXX` domain, one or more `testing-XXXX` groups, and one ore more dummy users are created and used during the tests and destroyed after running tests. `XXXX` will be filled with random identifiers.

Tip: The *halfstack* configuration and the `example-keypairs.json` fixture is compatible with this integration test suite.

How to run

Execute the gateway and at least one agent in their respective virtualenvs and hosts:

```
$ python -m ai.backend.client.gateway.server
$ python -m ai.backend.client.agent.server
$ python -m ai.backend.client.agent.watcher
```

Then run the tests:

```
$ export BACKEND_ENDPOINT=...
$ python -m pytest -m 'integration' tests
```

4.2 High-level Function Reference

4.2.1 Admin Functions

class ai.backend.client.func.admin.**Admin**

Provides the function interface for making admin GraphQL queries.

Note: Depending on the privilege of your API access key, you may or may not have access to querying/mutating server-side resources of other users.

classmethod **await query()**

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the staticmethod builtin.

4.2.2 Agent Functions

class ai.backend.client.func.agent.**Agent**

Provides a shortcut of Admin.query() that fetches various agent information.

Note: All methods in this function class require your API access key to have the *admin* privilege.

classmethod **async for ... in paginated_list()**

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

```
classmethod await detail()
```

```
classmethod(function) -> method
```

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

4.2.3 Auth Functions

```
class ai.backend.client.func.auth.Auth
```

Provides the function interface for login session management and authorization.

```
classmethod await login()
```

```
classmethod(function) -> method
```

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await logout()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await update_password()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

4.2.4 Configuration

```
ai.backend.client.config.get_env(key, default=<object object>, *,  
                                clean=<function <lambda>>)
```

Retrieves a configuration value from the environment variables. The given `key` is uppercased and prefixed by "BACKEND_" and then "SORNA_" if the former does not exist.

Parameters

- `key` (`str`) – The key name.

- **default** (*Any*) – The default value returned when there is no corresponding environment variable.
- **clean** (*Callable*[[*str*], *Any*]) – A single-argument function that is applied to the result of lookup (in both successes and the default value for failures). The default is returning the value as-is.

Returns The value processed by the *clean* function.

`ai.backend.client.config.get_config()`

Returns the configuration for the current process. If there is no explicitly set *APIConfig* instance, it will generate a new one from the current environment variables and defaults.

`ai.backend.client.config.set_config(conf)`

Sets the configuration used throughout the current process.

```
class ai.backend.client.config.APIConfig(*,          endpoint=None,          end-
                                         point_type=None,          do-
                                         main=None,          group=None,          ver-
                                         sion=None,          user_agent=None,
                                         access_key=None,          se-
                                         cret_key=None,          hash_type=None,
                                         vfolder_mounts=None,
                                         skip_sslcert_validation=None,
                                         connection_timeout=None,
                                         read_timeout=None,          announce-
                                         ment_handler=None)
```

Represents a set of API client configurations. The access key and secret key are mandatory – they must be set in either environment variables or as the explicit arguments.

Parameters

- **endpoint** (*Union*[*str*, *URL*, *None*]) – The URL prefix to make API requests via HTTP/HTTPS. If this is given as *str* and contains multiple URLs separated by comma, the underlying HTTP request-response facility will perform client-side load balancing and automatic fail-over using them, assuming that all those URLs indicates a single, same cluster. The users of the API and CLI will get network connection errors only when all of the given endpoints fail – intermittent failures of a subset of endpoints will be hidden with a little increased latency.
- **endpoint_type** (*Optional*[*str*]) – Either "api" or "session". If the endpoint type is "api" (the default if unspecified), it uses the access key and secret key in the configuration to access the manager

API server directly. If the endpoint type is "session", it assumes the endpoint is a Backend.AI console server which provides cookie-based authentication with username and password. In the latter, users need to use `backend.ai login` and `backend.ai logout` to manage their sign-in status, or the API equivalent in `login()` and `logout()` methods.

- **version** (`Optional[str]`) – The API protocol version.
- **user_agent** (`Optional[str]`) – A custom user-agent string which is sent to the API server as a User-Agent HTTP header.
- **access_key** (`Optional[str]`) – The API access key. If deliberately set to an empty string, the API requests will be made without signatures (anonymously).
- **secret_key** (`Optional[str]`) – The API secret key.
- **hash_type** (`Optional[str]`) – The hash type to generate per-request authentication signatures.
- **vfolder_mounts** (`Optional[Iterable[str]]`) – A list of vfolder names (that must belong to the given access key) to be automatically mounted upon any `Kernel.get_or_create()` calls.

DEFAULTS: `Mapping[str, Any] = {'connection_timeout': 10.0, 'domain': 'default', 'end`

The default values for config parameterse settable via environment variables except the access and secret keys.

endpoint

The currently active endpoint URL. This may change if there are multiple configured endpoints and the current one is not accessible.

Return type `URL`

endpoints

All configured endpoint URLs.

Return type `Sequence[URL]`

endpoint_type

The configured endpoint type.

Return type `str`

domain

The configured domain.

Return type `str`

group

The configured group.

Return type `str`

user_agent

The configured user agent string.

Return type `str`

access_key

The configured API access key.

Return type `str`

secret_key

The configured API secret key.

Return type `str`

version

The configured API protocol version.

Return type `str`

hash_type

The configured hash algorithm for API authentication signatures.

Return type `str`

vfolder_mounts

The configured auto-mounted vfolder list.

Return type `Sequence[str]`

skip_sslcert_validation

Whether to skip SSL certificate validation for the API gateway.

Return type `bool`

connection_timeout

The maximum allowed duration for making TCP connections to the server.

Return type `float`

read_timeout

The maximum allowed waiting time for the first byte of the response from the server.

Return type `float`

announcement_handler

The announcement handler to display server-set announcements.

Return type `Optional[Callable[[str], None]]`

4.2.5 KeyPair Functions

class ai.backend.client.func.keypair.**KeyPair**(*access_key*)

Provides interactions with keypairs.

classmethod **await create**()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod **await update**()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod **await delete**()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await list()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod async for ... in paginated_list()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

await info(fields=None)

Returns the keypair's information such as resource limits.

Parameters `fields` (`Optional[Iterable[str]]`) – Additional per-agent query fields to fetch.

New in version 18.12.

Return type `dict`

classmethod `await activate()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod `await deactivate()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

4.2.6 Manager Functions

class `ai.backend.client.func.manager.Manager`

Provides controlling of the gateway/manager servers.

New in version 18.12.

classmethod `await status()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await freeze()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await unfreeze()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await get_announcement()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await update_announcement()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await scheduler_op()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

4.2.7 Scaling Group Functions

class `ai.backend.client.func.scaling_group.ScalingGroup`(*name*)

Provides getting scaling-group information required for the current user.

The scaling-group is an opaque server-side configuration which splits the whole cluster into several partitions, so that server administrators can apply different auto-scaling policies and operation standards to each partition of agent sets.

classmethod `await list_available()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod `await list()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod `await detail()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await create()

```
classmethod(function) -> method
```

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await update()

```
classmethod(function) -> method
```

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await delete()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await associate_domain()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await dissociate_domain()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await dissociate_all_domain()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await associate_group()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await dissociate_group()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod `await dissociate_all_group()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

4.2.8 ComputeSession Functions

class `ai.backend.client.func.session.ComputeSession`(*name*,

owner_access_key=None)

Provides various interactions with compute sessions in Backend.AI.

The term 'kernel' is now deprecated and we prefer 'compute sessions'. However, for historical reasons and to avoid confusion with client sessions, we keep the backward compatibility with the naming of this API function class.

For multi-container sessions, all methods take effects to the master container only, except `destroy()` and `restart()` methods. So it is the user's responsibility to distribute uploaded files to multiple containers using explicit copies or virtual folders which are commonly mounted to all containers belonging to the same compute session.

classmethod `async for ... in paginated_list()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

...

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await hello()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

...

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod async for ... in get_task_logs()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

...

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await get_or_create()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod `await create_from_template()`

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

await destroy `(*, forced=False)`

Destroys the compute session. Since the server literally kills the container(s), all ongoing executions are forcibly interrupted.

await restart `()`

Restarts the compute session. The server force-destroys the current running container(s), but keeps their temporary scratch directories intact.

await interrupt `()`

Tries to interrupt the current ongoing code execution. This may fail without any explicit errors depending on the code being executed.

await complete `(code, opts=None)`

Gets the auto-completion candidates from the given code string, as if a user has pressed the tab key just after the code in IDEs.

Depending on the language of the compute session, this feature may not be supported. Unsupported sessions returns an empty list.

Parameters

- **code** (`str`) – An (incomplete) code text.
- **opts** (`Optional[dict]`) – Additional information about the current cursor position, such as row, col, line and the remainder text.

Return type `Iterable[str]`**Returns** An ordered list of strings.**await get_info()**

Retrieves a brief information about the compute session.

await get_logs()

Retrieves the console log of the compute session container.

await execute(*run_id=None, code=None, mode='query', opts=None*)

Executes a code snippet directly in the compute session or sends a set of build/clean/execute commands to the compute session.

For more details about using this API, please refer [the official API documentation](#).**Parameters**

- **run_id** (`Optional[str]`) – A unique identifier for a particular run loop. In the first call, it may be `None` so that the server auto-assigns one. Subsequent calls must use the returned `runId` value to request continuation or to send user inputs.
- **code** (`Optional[str]`) – A code snippet as string. In the continuation requests, it must be an empty string. When sending user inputs, this is where the user input string is stored.
- **mode** (`str`) – A constant string which is one of "query", "batch", "continue", and "user-input".
- **opts** (`Optional[dict]`) – A dict for specifying additional options. Mainly used in the batch mode to specify build/clean/execution commands. See [the API object reference](#) for details.

Returns [An execution result object](#)**await upload(*files, basedir=None, show_progress=False*)**

Uploads the given list of files to the compute session. You may refer them in the batch-mode execution or from the code executed in the server afterwards.

Parameters

- **files** (`Sequence[Union[str, Path]]`) – The list of file paths in the client-side. If the paths include directories, the location of them in

the compute session is calculated from the relative path to *basedir* and all intermediate parent directories are automatically created if not exists.

For example, if a file path is `/home/user/test/data.txt` (or `test/data.txt`) where *basedir* is `/home/user` (or the current working directory is `/home/user`), the uploaded file is located at `/home/work/test/data.txt` in the compute session container.

- **basedir** (`Union[str, Path, None]`) – The directory prefix where the files reside. The default value is the current working directory.
- **show_progress** (`bool`) – Displays a progress bar during uploads.

await download(*files*, *dest*='.', *show_progress*=False)

Downloads the given list of files from the compute session.

Parameters

- **files** (`Sequence[Union[str, Path]]`) – The list of file paths in the compute session. If they are relative paths, the path is calculated from `/home/work` in the compute session container.
- **dest** (`Union[str, Path]`) – The destination directory in the client-side.
- **show_progress** (`bool`) – Displays a progress bar during downloads.

await list_files(*path*='.')

Gets the list of files in the given path inside the compute session container.

Parameters *path* (`Union[str, Path]`) – The directory path in the compute session.

listen_events()

Opens the stream of the kernel lifecycle events. Only the master kernel of each session is monitored.

Return type `SSEContextManager`

Returns a `StreamEvents` object.

stream_events()

Opens the stream of the kernel lifecycle events. Only the master kernel of each session is monitored.

Return type `SSEContextManager`

Returns a `StreamEvents` object.

stream_pty()

Opens a pseudo-terminal of the kernel (if supported) streamed via websockets.

Return type *WebSocketContextManager*

Returns a *StreamPty* object.

stream_execute(*code=''*, *, *mode='query'*, *opts=None*)

Executes a code snippet in the streaming mode. Since the returned websocket represents a run loop, there is no need to specify *run_id* explicitly.

Return type *WebSocketContextManager*

class ai.backend.client.func.session.**StreamPty**(*session*, *underlying_response*, ***kwargs*)

A derivative class of *WebSocketResponse* which provides additional functions to control the terminal.

4.2.9 Session Template Functions

class ai.backend.client.func.session_template.**SessionTemplate**(*template_id*, *owner_access_key=None*)

classmethod **await create**()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod **await list_templates**()

classmethod(function) -> method

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

```
await get(body_format='yaml')
```

Return type `str`

```
await put(template)
```

Return type `Any`

```
await delete()
```

Return type `Any`

4.2.10 Virtual Folder Functions

```
class ai.backend.client.func.vfolder.VFolder(name)
```

```
classmethod await create()
```

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

```
classmethod await delete_by_id()
```

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

...

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await list()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

...

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod async for ... in paginated_list()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

...

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await list_hosts()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await list_all_hosts()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await list_allowed_types()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

await info()

```
await delete()
await rename(new_name)
await upload(files, basedir=None, show_progress=False)
await mkdir(path)
await request_download(filename)
await rename_file(target_path, new_name)
await delete_files(files, recursive=False)
await download(files, show_progress=False)
await list_files(path='.')
await invite(perm, emails)
```

```
classmethod await invitations()
```

```
    classmethod(function) -> method
```

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

```
classmethod await accept_invitation()
```

```
    classmethod(function) -> method
```

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. C.f()) or on an instance (e.g. C().f()). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await delete_invitation()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await get_fstab_contents()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await list_mounts()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):
```

```
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await mount_host()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

classmethod await umount_host()

`classmethod(function) -> method`

Convert a function to be a class method.

A class method receives the class as implicit first argument, just like an instance method receives the instance. To declare a class method, use this idiom:

```
class C: @classmethod def f(cls, arg1, arg2, ...):  
    ...
```

It can be called either on the class (e.g. `C.f()`) or on an instance (e.g. `C().f()`). The instance is ignored except for its class. If a class method is called for a derived class, the derived class object is passed as the implied first argument.

Class methods are different than C++ or Java static methods. If you want those, see the `staticmethod` builtin.

await leave()

4.3 Low-level SDK Reference

4.3.1 Base Function

This module defines a few utilities that ease complexities to support both synchronous and asynchronous API functions, using some tricks with Python metaclasses.

Unless your are contributing to the client SDK, probably you won't have to use this module directly.

4.3.2 Request API

This module provides low-level API request/response interfaces based on aiohttp.

Depending on the session object where the request is made from, *Request* and *Response* differentiate their behavior: works as plain Python functions or returns awaitables.

```
class ai.backend.client.request.Request(session, method='GET',  
                                         path=None, content=None, *, con-  
                                         tent_type=None, params=None,  
                                         reporthook=None, over-  
                                         ride_api_version=None)
```

The API request object.

```
with async with fetch(**kwargs) as Response
```

Sends the request to the server and reads the response.

You may use this method either with plain synchronous *Session* or *AsyncSession*. Both the followings patterns are valid:

```
from ai.backend.client.request import Request  
from ai.backend.client.session import Session  
  
with Session() as sess:  
    rqst = Request(sess, 'GET', ...)  
    with rqst.fetch() as resp:  
        print(resp.text())
```

```
from ai.backend.client.request import Request  
from ai.backend.client.session import AsyncSession  
  
async with AsyncSession() as sess:  
    rqst = Request(sess, 'GET', ...)  
    async with rqst.fetch() as resp:  
        print(await resp.text())
```

Return type *FetchContextManager*

`async` with `connect_websocket(**kwargs)` as `WebSocketResponse` or its

derivatives

Creates a WebSocket connection.

Warning: This method only works with `AsyncSession`.

Return type `WebSocketContextManager`

content

Retrieves the content in the original form. Private codes should NOT use this as it incurs duplicate encoding/decoding.

Return type `Union[bytes, bytearray, str, StreamReader, IOBase, None]`

`set_content(value, *, content_type=None)`

Sets the content of the request.

Return type `None`

`set_json(value)`

A shortcut for `set_content()` with JSON objects.

Return type `None`

`attach_files(files)`

Attach a list of files represented as `AttachedFile`.

Return type `None`

`connect_events(**kwargs)`

Creates a Server-Sent Events connection.

Warning: This method only works with `AsyncSession`.

Return type `SSEContextManager`

```
class ai.backend.client.request.Response(session, underlying_response, *,
                                         async_mode=False, **kwargs)
```

```
class ai.backend.client.request.WebSocketResponse(session, underlying_response, **kwargs)
```

A high-level wrapper of `aihttp.ClientWebSocketResponse`.

```
class ai.backend.client.request.FetchContextManager(session,  
                                                    rqst_ctx_builder,      *,  
                                                    response_cls=<class  
                                                    'ai.backend.client.request.Response'>,  
                                                    check_status=True)
```

The context manager returned by `Request.fetch()`.

It provides both synchronous and asynchronous context manager interfaces.

```
class ai.backend.client.request.WebSocketContextManager(session,  
                                                         ws_ctx_builder,  
                                                         *, on_enter=None,  
                                                         re-  
                                                         sponse_cls=<class  
                                                         'ai.backend.client.request.WebSocketF
```

The context manager returned by `Request.connect_websocket()`.

```
class ai.backend.client.request.AttachedFile(filename,      stream,      con-  
                                              tent_type)
```

A struct that represents an attached file to the API request.

Parameters

- **filename** (*str*) – The name of file to store. It may include paths and the server will create parent directories if required.
- **stream** (*Any*) – A file-like object that allows stream-reading bytes.
- **content_type** (*str*) – The content type for the stream. For arbitrary binary data, use “application/octet-stream”.

content_type

Alias for field number 2

count()

Return number of occurrences of value.

filename

Alias for field number 0

index()

Return first index of value.

Raises `ValueError` if the value is not present.

stream

Alias for field number 1

4.3.3 Exceptions

class `ai.backend.client.exceptions.BackendError`

Exception type to catch all ai.backend-related errors.

with_traceback()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

class `ai.backend.client.exceptions.BackendAPIError(status, reason, data)`

Exceptions returned by the API gateway.

with_traceback()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

class `ai.backend.client.exceptions.BackendClientError`

Exceptions from the client library, such as argument validation errors and connection failures.

with_traceback()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

4.3.4 Miscellaneous Utilities

`ai.backend.client.utils.undefined`

A placeholder to signify an undefined value as a singleton object of Undefined and distinguish it from a null (None) value.

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